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(54) PATTERNED RETARDER FILM AND METHOD FOR MANUFACTURING THE SAME

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(22) Filed: **Dec. 20, 2010**

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Related U.S. Application Data

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(51) **Int. Cl.**
G02F 1/1335 (2006.01)

(52) **U.S. Cl.**
USPC **349/117**; 349/118; 349/119

(58) **Field of Classification Search**
None
See application file for complete search history.

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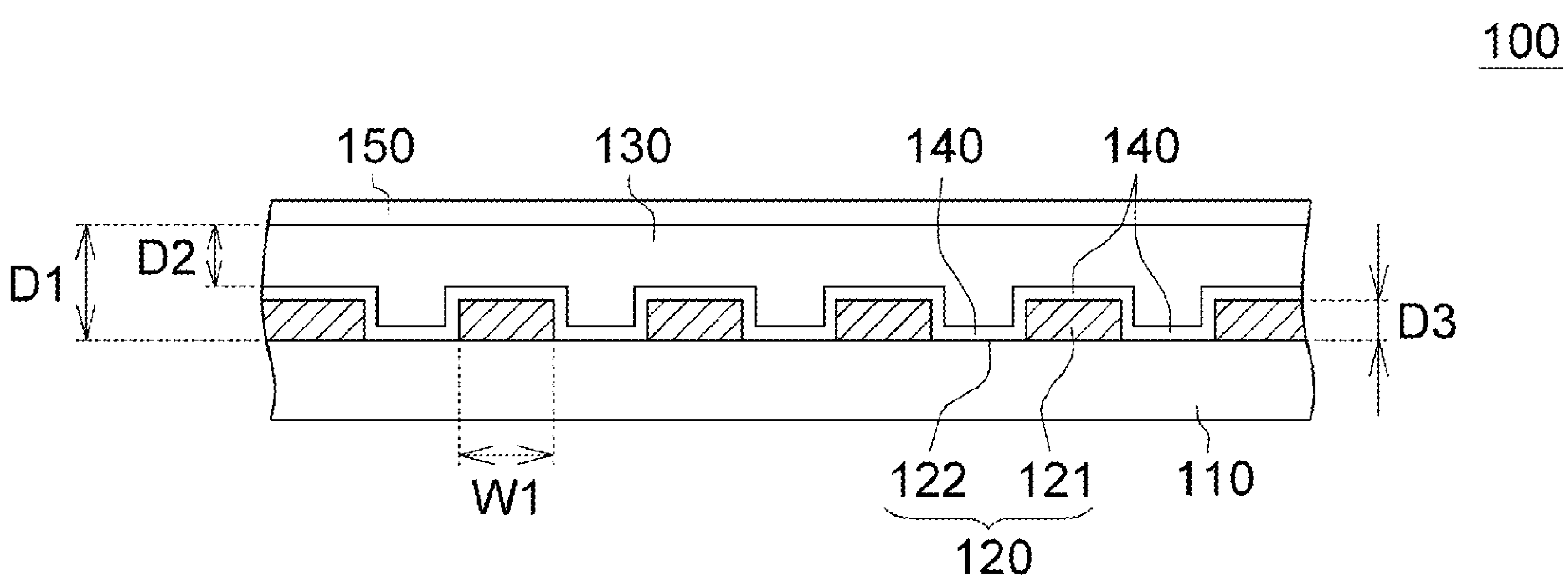
(57) **ABSTRACT**

A patterned retarder film comprises a first substrate, a pattern configuration, an alignment layer formed on the pattern configuration, and a liquid crystal layer disposed on the alignment layer. The pattern configuration comprises a plurality of first regions and a plurality of second regions, wherein the first regions are grating relief structure and interleaved with the second regions. A liquid crystal layer is coated on the alignment layer to cover the first regions and the second regions of the pattern configuration to a plane with a determined thickness on the surface of the first regions. The first phase retardation of the liquid crystal layer on the first regions and the second phase retardation of the liquid crystal layer on the second regions are different by 180°. The method for manufacturing the same is disclosed.

20 Claims, 5 Drawing Sheets



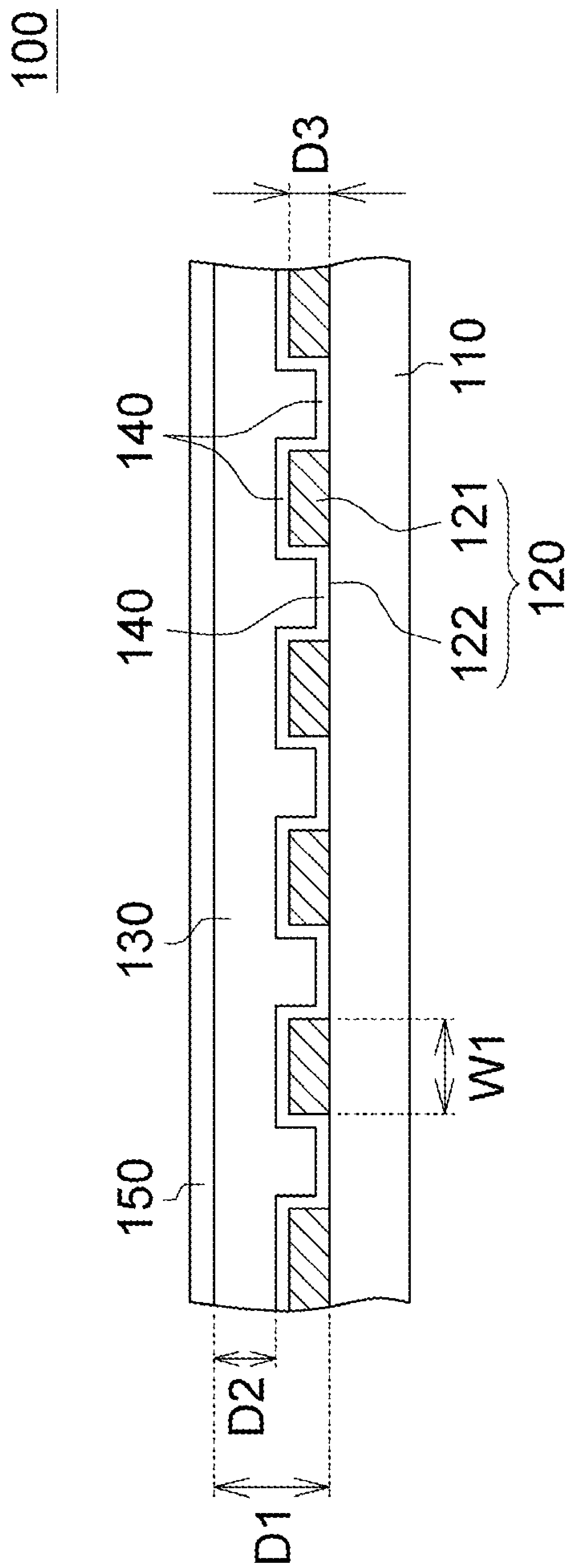


FIG. 1

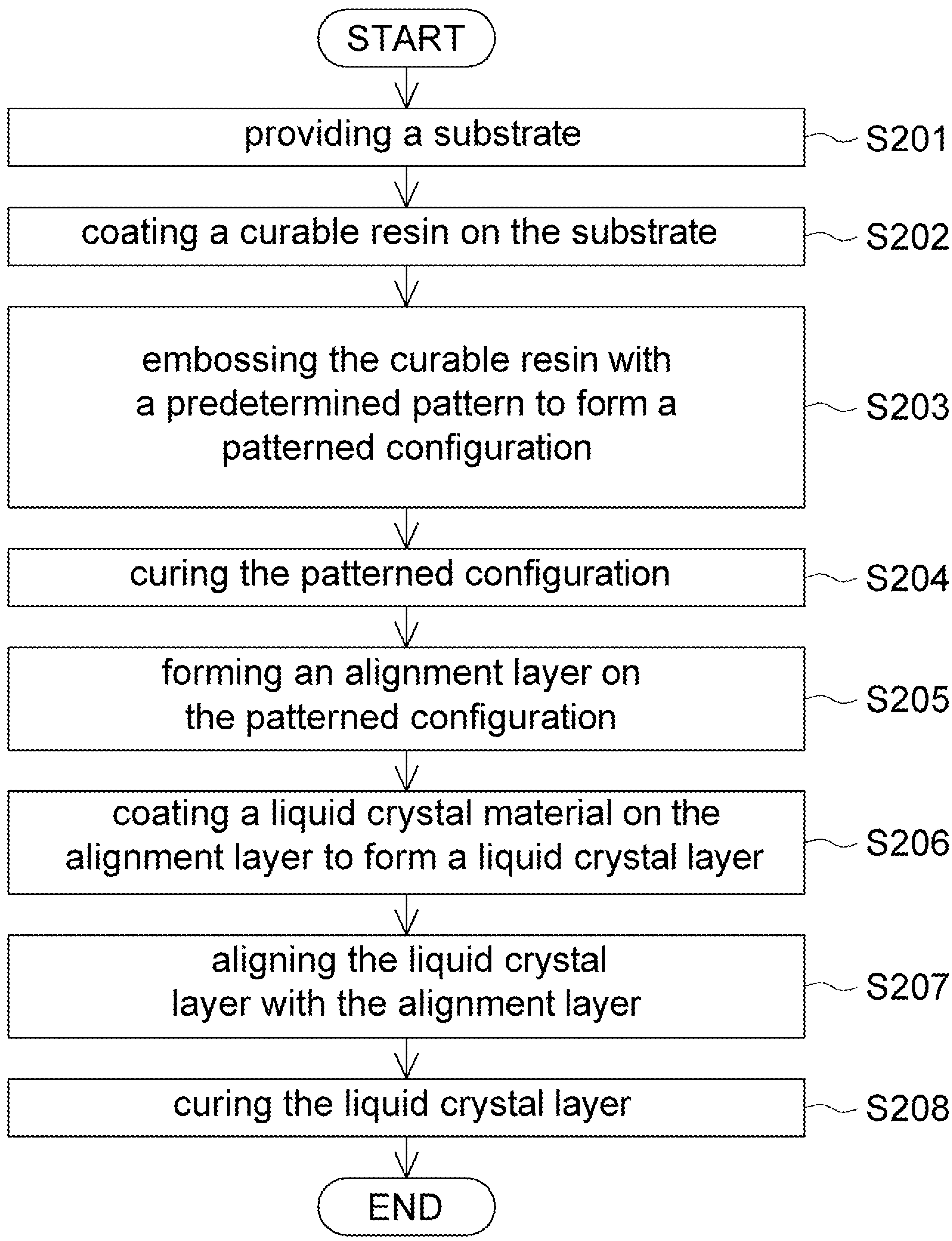

START
providing a substrate
S201
coating a curable resin on the substrate
S202
embossing the curable resin with a predetermined pattern to form a patterned configuration
S203
curing the patterned configuration
S204
forming an alignment layer on the patterned configuration
S205
coating a liquid crystal material on the alignment layer to form a liquid crystal layer
S206
aligning the liquid crystal layer with the alignment layer
S207
curing the liquid crystal layer
S208
END

FIG. 2

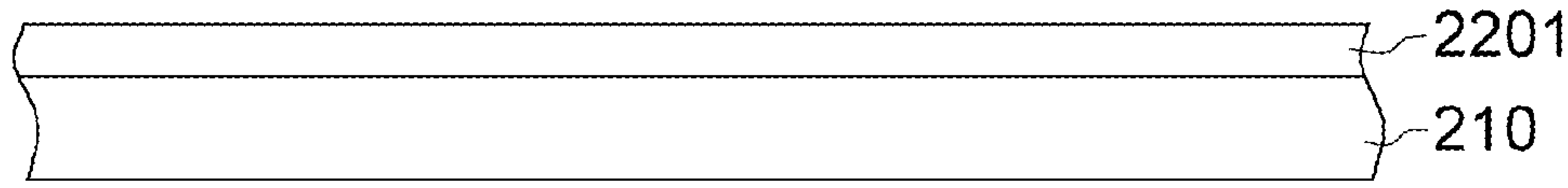


FIG. 3A

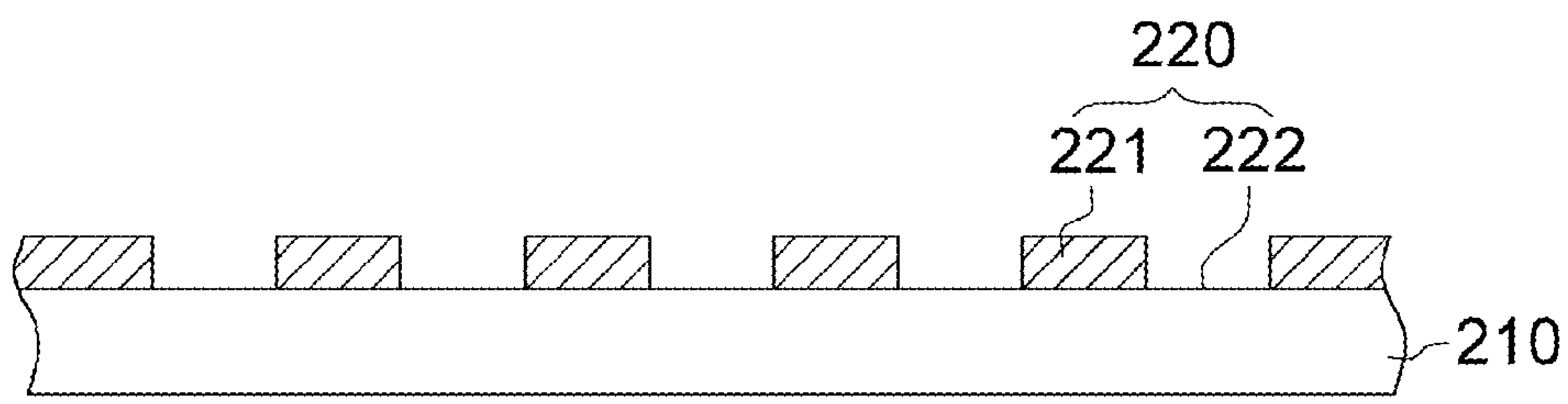


FIG. 3B

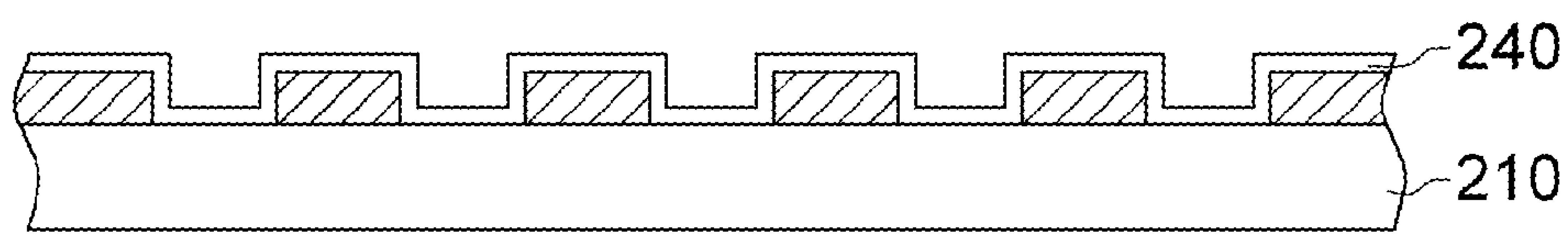


FIG. 3C

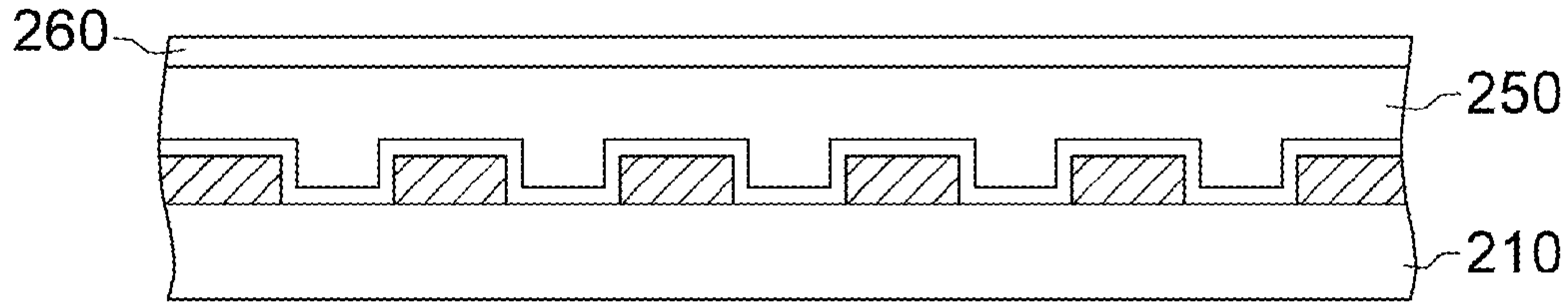


FIG. 3D

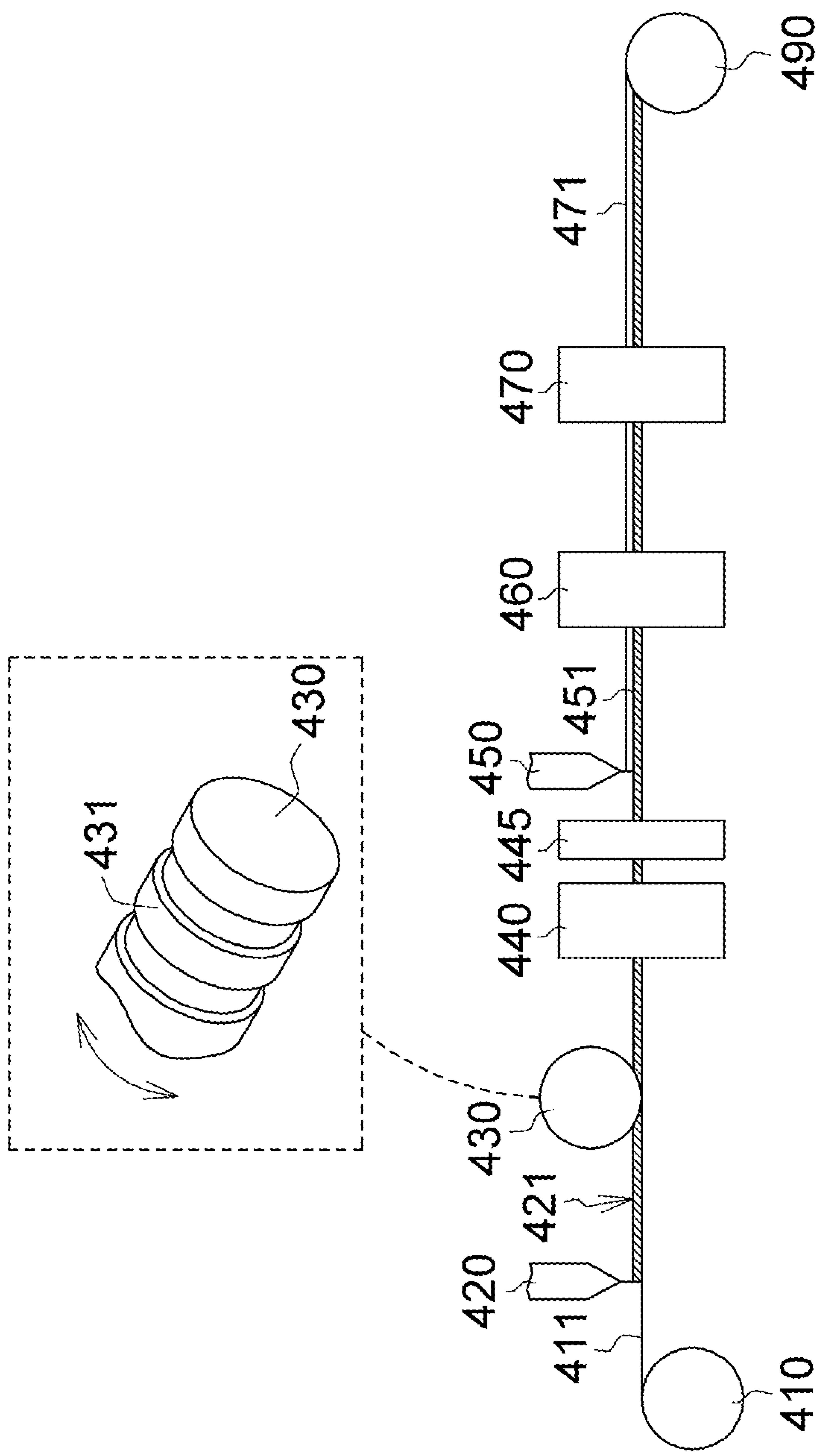


FIG. 4

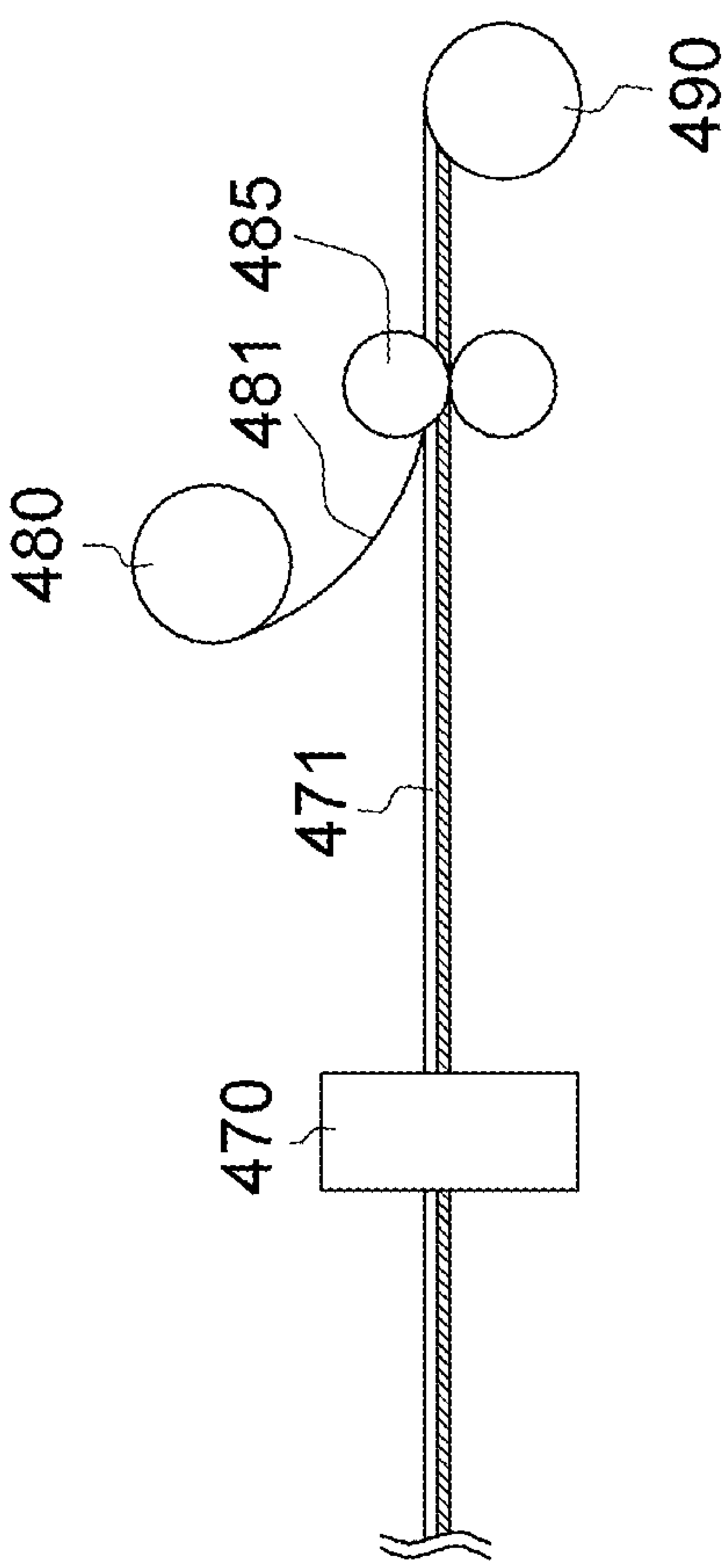


FIG. 5

PATTERNED RETARDER FILM AND METHOD FOR MANUFACTURING THE SAME

This application claims the benefit of U.S. provisional application Ser. No. 61/348,768, filed on May 27, 2010, and U.S. provisional application Ser. No. 61/367,033, filed on Jul. 23, 2010, the subject matters of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates in general to a patterned retarder film and a method for manufacturing the same, and more particularly to a patterned retarder film used in stereoscopic display systems and a method for manufacturing the same.

2. Description of the Related Art

In recent years, stereoscopic display systems with enhanced image quality have drawn more attention to the industry and become more popular to customers. It is known that applying a patterned retarder film to a liquid crystal display screen, a stereo imaging can thus be provided for audience wearing a pair of polarization glasses.

Some methods for manufacturing patterned retarder film are provided in the related art, such as a method of making a patterned retarder disclosed in U.S. Pat. No. 6,624,863 and a micro-retarder plate using a single plate with phase retardation disclosed in U.S. Pat. No. 6,498,679.

The present invention intends to provide a patterned retarder film with a novel structure and a method for manufacturing the same and more particularly to a patterned retarder film used in stereoscopic display systems and a method for manufacturing the same with an embossing treatment.

SUMMARY OF THE INVENTION

The present invention is directed to a patterned retarder film for a stereographic display system and a method for manufacturing the same. According to an aspect of the present invention, a patterned retarder film is provided. The present patterned retarder film comprises a substrate, a pattern configuration of a curable resin embossed on the first substrate, an alignment layer formed on the pattern configuration, and a liquid crystal layer coated on the alignment layer with a determined thickness. The pattern configuration on the substrate is formed by embossing a curable resin with a predetermined pattern comprising a plurality of first regions and a plurality of second regions, wherein the structure of the first regions and the second regions is grating-like stripe structure and parallel to each other and the structure of the first regions relative to that of the second regions is relief structure and interleaved with each other. The liquid crystal layer is coated on the alignment layer to cover the first regions and the second regions of the pattern configuration to a plane with a determined thickness on the surface of the first regions. The first phase retardation of the liquid crystal layer on the first regions and the second phase retardation of the liquid crystal layer on the second regions are different by 180°.

According to another aspect of the present invention, a method for manufacturing a patterned retarder film is provided. A method for manufacturing a patterned retarder film comprises the steps of providing a substrate; coating a curable resin on the first substrate; embossing the curable resin with a predetermined pattern to form a pattern configuration comprising a plurality of first regions and a plurality of second regions, wherein the structure of the first regions and the second regions is grating-like stripe structure and parallel to each other and the structure of the first regions relative to that of the second regions is relief structure and interleaved with each other; curing the pattern configuration; forming an alignment layer on the pattern configuration; coating a liquid crystal layer on the alignment layer to cover the first regions and the second regions of the pattern configuration to a plane with a determined thickness on the surface of the first regions; aligning the liquid crystal layer with the alignment layer; and curing the liquid crystal layer; wherein the first phase retardation of the liquid crystal layer on the first regions and the second phase retardation of the liquid crystal layer on the second regions are different by 180°.

In another aspect of the patterned retarder film of present invention, the present patterned retarder film is adhered to at least one functional optical film such as, for example, polarizing film, hard-coating film, low reflective film, anti-reflective film and anti-glaring film.

In further another aspect of the patterned retarder film of the present invention, the patterned retarder film is adhered to a display panel to provide a stereo image to the viewers.

The above and other aspects of the invention will become better understood with regard to the following detailed description of the preferred but non-limiting embodiment(s). The following description is made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of a patterned retarder film of a preferred embodiment of the present invention;

FIG. **2** shows a flow chart of a method for manufacturing the patterned retarder film of a preferred embodiment of the present invention;

FIGS. **3**A to **3**D illustrate the steps in a method for manufacturing a patterned retarder film of an embodiment of the present invention; and

FIG. **4** is a diagrammatic view of a system used for manufacturing a patterned retarder film of an embodiment of the present invention.

FIG. **5** is a diagrammatic view of a system used for manufacturing a patterned retarder film of another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Please note the drawings shown in the Figures are for illustrative purposes only and not to scale.

A patterned retarder film **100** of a preferred embodiment of the present invention is shown in FIG. **1**. The patterned retarder film **100** comprises a substrate **110**, a pattern configuration **120** embossed with a curable resin formed on the substrate **110**, an alignment layer **140** formed on the surface of the pattern configuration **120**, and a liquid crystal layer **130** coated on the alignment layer **140** with a determined thickness. The pattern configuration **120** comprises a plurality of first regions **121** and a plurality of second regions **122** on the substrate **110**, wherein the structure of the first regions **121** and that of the second regions **122** is grating-like stripe structure and parallel to each other and the structure of the first regions **121** relative to that of the second regions **122** is relief structure and interleaved with each other. The liquid crystal layer **130** is coated on the alignment layer **140**, which fills the second regions **122** and fully covers the top surface of the first regions **121** with a determined thickness D**2** on the surface of the first regions **121**. The thickness of the liquid crystal layer

130 is determined in order to enable the first phase retardation of the liquid crystal layer **130** on the first regions **121** and the second phase retardation of the liquid crystal layer **130** on the second regions **122** to be different by 180°.

The phase retardation of the substrate **110** is less than 90° and preferably is substantial 0°. The substrate **110** can be a film of a poly(ethylene terephthalate) (PET), polycarbonate (PC), triacetyl cellulose (TAC), poly(methyl methacrylate) (PMMA) or cyclo-olefin polymer (COP). The thickness of the substrate **110** is in the range of 30 microns to 300 microns.

The pattern configuration **120** is formed by embossing a curable resin. The curable resin is selected from the group consisting of a UV curable resin and a thermo-curable resin. The curable resin can be a resin of acrylic resin, silicone and polyurethane. The pattern configuration **120** is embossed to form a plurality of first regions **121** and a plurality of second regions **122**, wherein the structure of the first regions **121** and the second regions **122** is grating-like stripe structure and parallel to each other and the structure of the first regions **121** relative to that of the second regions **122** is relief structure. The phase retardation of the curable resin is substantial 0°.

The dimensions of the first regions **121** and second regions **122** of the pattern configuration **120** is determined by the polymerizable liquid crystal material used for the liquid crystal layer **130** and the pixel size, the resolution and viewing distance of a display system which the present patterned retarder film is adhered to. The difference between the first phase retardation of the first regions **121** and the second phase retardation of the second regions **122** results from the difference between the different thickness of the liquid crystal layer **130** on the first regions **121** and second regions **122** respectively. The thickness of the liquid crystal layer **130** on the first regions **121** is D**1** and the thickness of the liquid crystal layer **130** on the second regions **122** is D**2** as shown in FIG. **1**. The difference of the thickness of the liquid crystal layer **130** on the first and the second regions **121**, **122** depends on the highness D**3** of the first regions **121**. Therefore, the highness D**3** of the first regions **121** is determined by that a phase retardation as, for example, ½λ (wavelength unit) is provided at such a thickness of a liquid crystal layer **130**. In addition, the phase retardation of a liquid crystal layer **130** depends on the properties of the polymerizable liquid crystal materials used, such as the phase retardation thereof provided, and the thickness thereof, which are well known to any artisan skilled in the art. In the present invention, the highness D**3** of the relief structure of the first regions **121** is in the range of 0.1 to 9.9 microns (μm). The width W**1** of the relief structure of the first regions **121** is determined by the pixel size and the resolution of the display which the present patterned retarder film is adhered to, and viewing distance thereof. The width W**1** of the relief structure of the first regions **121** and the pitch between every two first regions **121** are in the range of 10 to 900 microns (μm). Typically, the pitch between every two relief structure of the first regions **121** is selected from a range between 10 microns to 900 microns. For example, for a 24-inch LC display monitor, the width W**1** of the relief structure of the first regions **121** and the pitch between two first regions **121** are about 250 microns. In the embodiment of the present invention that a substrate with low phase retardation is used, the highness D**3** of the relief structure of the pattern configuration **120** and the thickness of the liquid crystal layer **130** can be selected in order to enable the first phase retardation of the liquid crystal layer **130** on the first regions **121** and the second phase retardation of the liquid crystal layer **130** on the second regions **122** to be different by 180°.

The alignment layer **140** is formed on the pattern configuration **120** by a process selected from the group consisting of micro-scratch alignment treatment, rubbing treatment, photo-alignment, SiO_2 evaporation, and ion beam alignment.

The liquid crystal material for the liquid crystal layer **130** used in the present invention is a polymerizable liquid crystal, such as, for example BASF LC242 (photopolymerizable liquid crystal diacrylate, available from BASF Co., Germany) and RMS10-021(UV curable reactive mesogen solution, available from Merck Display Tech Ltd, Taiwan.). As mentioned above, the thickness of the liquid crystal layer **130** determines the difference of the first phase retardation and the second phase retardation. In a preferred embodiment, the thickness D**2** of the liquid crystal layer **130** on the first region **121** is about 0.5 microns to 2 microns. The thickness D**1** of the liquid crystal layer **130** on the second region **122** is about 1.5 microns to 6 microns. In one embodiment of the patterned retarder film of the present invention, the liquid crystal material was BASF LC242 (photopolymerizable liquid crystal diacrylate, available from BASF Co., Germany), wherein the thickness of the liquid crystal layer **130** on the first region **121** is about 0.89 microns and the thickness of the liquid crystal layer **130** on the second region **122** is about 2.67 microns. In another embodiment of the patterned retarder film of the present invention, the liquid crystal material is RMS10-021 (UV curable reactive mesogen solution, available from Merck Display Tech Ltd, Taiwan), wherein the thickness D**2** of the liquid crystal layer **130** on the first regions **121** is about 1.05 microns and the thickness D**1** of the liquid crystal layer **130** on the second regions **122** is about 3.05 microns.

In an embodiment of the present patterned retarder film **100**, a release film **150** is adhered to the liquid crystal layer **130**, which can be removed before a functional optical film, such as a polarizer film, is adhered on the liquid crystal layer **130**. In a further preferred embodiment of the patterned retarder film of the present invention, the present patterned retarder film **100** is able to be adhered to at least one functional optical film such as, for example, polarizing film, hard-coating film, low reflective film, anti-reflective film and anti-glaring film or to a display panel directly.

A preferred embodiment of the method for manufacturing the patterned retarder film **100** of the present invention is illustrated by FIG. **2** together with FIGS. **3**A to **3**D. FIG. **2** is a flow chart of a method for manufacturing a patterned retarder film of an embodiment of the present invention. FIGS. **3**A to **3**D illustrate the steps in a method for manufacturing a patterned retarder film of an embodiment of the present invention.

In step S**201**, a substrate **210** is provided, as shown in FIG. **3**A. The substrate **210** can be a poly(ethylene terephthalate) (PET), polycarbonate (PC), triacetyl cellulose (TAC), poly (methyl methacrylate) (PMMA) or cyclo-olefin polymer (COP). The thickness of the substrate **210** is in the range of 30 microns to 300 microns.

In the step S**202**, as shown in FIG. **3**A, a curable resin **2201** is coated on the substrate **210**. In the present embodiment, the phase retardation of the curable resin **2201** is substantially zero. The curable resin **2201** is a UV curable resin or a thermo-curable resin as the mentioned above.

After the curable resin **2201** is coated on the substrate **210**, the curable resin **2201** is conducted an embossing treatment as step S**203**. As shown in FIG. **3**B, the curable resin **2201** is embossed to form a plurality of first regions **221** and a plurality of second regions **222**. The highness and width of the relief structure of the first regions **221** and the width between every two adjacent relief structure of the first regions **221** are as above mentioned.

The embossing treatment of the step S**203** is effected by a stamp or a roller having a predetermined pattern on the surface thereof. In an embodiment of the method of the present invention, the embossing treatment is effected by such as a grooved roller **430** as shown in FIG. **4**. The surface of the roller **430** is molded with a set of relief structures **431** which are grating-like stripe structure and parallel to each other. The set of relief structures **431** is extended along the rotating direction of the roller **430**. In another embodiment of the method of the present invention, the set of the relief structures **431** is arranged in a direction perpendicular to the rotating direction of the roller **430** (not shown in Drawings).

In the step S**204**, the pattern configuration **220**, as shown in FIG. **3**B, is cured. In an embodiment of the method of the present invention, the curable resin is a UV curable resin and cured by UV radiation. In another embodiment of the method of the present invention, the curable resin is a thermo-curable resin and cured by heating treatment.

As shown in FIG. **3**C, in the step S**205**, the alignment layer **240** is formed on surface of the pattern configuration **220**. The alignment layer **240** is formed, for example, by micro-scratch alignment treatment, rubbing treatment, photo-alignment, SiO_2 evaporation, or ion beam alignment.

Referring to FIG. **3**D, in the step S**206**, a liquid crystal layer **250** is coated on the alignment layer **240** with a determined thickness. In the present embodiment, the liquid crystal material for liquid crystal layer **250** of the present invention is a polymerizable liquid crystal, such as, for example BASF LC242 (photopolymerizable liquid crystal diacrylate, available from BASF Co., Germany) and RMS10-021 (UV curable reactive mesogen solution, available from Merck Display Tech Ltd, Taiwan.). The liquid crystal was mixed in a solvent for conveniently coating on the alignment layer **240**. The solid content of the liquid crystal solution is in the range from 10% to 50%. In a preferred embodiment of the method of the present invention, the solid content of the liquid crystal solution in the solvent is about 20%. The solvent used in the method of the present invention is known to an artisan skilled in the relevant art, such as, for example, propylene glycol monomethyl ether acetate (PGMEA).

In step S**207** of FIG. **2**, the coated liquid crystal layer **250** is conducted a heating treatment to remove the solvent and simultaneously align the liquid crystal with the alignment layer **240**. The temperature of the heating treatment depends on the properties of the polymerizable liquid crystal materials. The heating treatment is conducted at a temperature in the range between about 20° C. to about 100° C., preferably from about 50° C. to about 100° C. In a preferred embodiment of the method of the present invention, the temperature of the heat treatment is at about 70° C. The temperature of the heating treatment was controlled in order to effect the alignment of the liquid crystal layer **250** to the alignment layer **240**. After heating treatment, the thickness of the liquid crystal layer **250** on the first regions **221** is about 0.5 microns to 2 microns and that on the second regions **222** is about 1.5 microns to 6 microns. In one embodiment of the method of the present invention, the liquid crystal material was BASF LC242 (photopolymerizable liquid crystal diacrylate, available from BASF Co., Germany), wherein after heating treatment, the thickness of the liquid crystal layer **250** on the first regions **221** is about 0.89 microns and the thickness of the liquid crystal layer **250** on the second regions **222** is about 2.67 microns. In another embodiment of the patterned retarder film of the present, the liquid crystal material is RMS10-021 (UV curable reactive mesogen solution, available from Merck Display Tech Ltd, Taiwan), wherein the thickness of the liquid crystal layer **250** on the first regions **221** is about 1.05 microns and the thickness of the liquid crystal layer **250** on the second regions **222** is about 2.1 microns.

Next, in the step S**208**, the liquid crystal layer **250** is cured by UV radiation. In another embodiment, the liquid crystal layer **250** is cured by heating treatment. After the liquid crystal layer **250** is cured, the patterned retarder film can be adhered to a display panel directly or to an optical film such as polarizing film. Alternatively, the patterned retarder film was further adhered to a second film. In one embodiment of the present invention, the second film is a release film **260** which can be removed when the present patterned retarder film is adhered to a display panel or to an optical film such as polarizing film. In another preferred embodiment of the method of the present invention, the second film is a polarizing film directed adhered on the patterned liquid crystal layer **250**. The present patterned retarder film also can be adhered with at least one of functional optical films selected from a group consisting of hard-coating film, low reflective film, anti-reflective film and anti-glaring film on the surface of the base film opposed to the surface for forming the alignment layer **240** in order to provide desired additional optical functionalities.

The present method for manufacturing a patterned retarder film can be conducted in a batch production or a continuous production. FIG. **4** is a diagrammatic view of a system used for manufacturing a patterned retarder film of an embodiment of the present invention in a continuous production, such as, for example, a roll-to-roll system **400**. The system **400** is for manufacturing the present patterned retarder film. The substrate **411** is unwound from a first roller **410** and conveyed to pass through a coating means **420** to coat a curable resin **421** thereon. The curable resin **421** is embossed by a roller **430** to form a pattern configuration and then cured via curable means **440**, such as a UV radiation means. The cured resin **421** is conducted an alignment treatment to form an alignment layer thereon via an alignment device **445**, such as a rubbing treatment device. A liquid crystal coating **451** is coated on the alignment layer via a liquid crystal coating means **450**. The liquid crystal coating **451** is heated at a temperature in a range of about 20° C. to about 100° C., preferably in a range of about 50° C. to about 100° C. and more preferably at about 70° C., under a heating means **460** to remove the solvent contained in the liquid crystal coating **451** and simultaneously align the said liquid crystal coating **451** to the alignment layer. The aligned liquid crystal layer **451** is subsequently cured via a curing means **470**, such as a UV-curing means or a thermo-curing means. After curing treatment, a patterned retarder film **471** is sequentially wounded on a second roller **490**. In another embodiment of the method for manufacturing a patterned retarder film of the present invention, the patterned retarder film **471** can be laminated with a release film **481** which is rewound from a third roller **480**. The release film **481** is in a direction to dispose on the patterned retarder film **471**. The release film **481** and the patterned retarder film **471** are passed through a laminating means **485** and sequentially wound on a roller **490**, as shown in FIG. **5**. The film wound on the third roller **480** can be an optical film selected from the group consisting of polarizing film, hard-coating film, low reflective film, anti-reflective film and anti-glaring film.

While the invention has been described by way of example (s) and in terms of the preferred embodiment(s), it is to be understood that the invention is not limited thereto. On the contrary, it is intended to cover various modifications and similar arrangements and procedures, and the scope of the appended claims therefore should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements and procedures.

What is claimed is:

1. A patterned retarder film, comprising:

a substrate;

a pattern configuration on the substrate formed by embossing a curable resin with a predetermined pattern, comprising a plurality of first regions and a plurality of second regions, wherein the structure of the first regions and the second regions is grating-like stripe structure, the first regions and the second regions are parallel and interleaved with each other, and the structure of the first regions is relief structures;

an alignment layer formed on the pattern configuration; and

a liquid crystal layer coated on the alignment layer to cover the first regions and the second regions of the pattern configuration to a plane with a determined thickness on the surface of the first regions;

wherein the first phase retardation of the liquid crystal layer on the first regions and the second phase retardation of the liquid crystal layer on the second regions are different by 180°.

2. The patterned retarder film according to claim **1**, wherein the thickness of the substrate is in the range of 30-300 microns (μm).

3. The patterned retarder film according to claim **1**, wherein the substrate is selected from the group consisting of poly (ethylene terephthalate), polycarbonate, triacetate cellulose, poly(methyl methacrylate), and cyclo-olefin polymer.

4. The patterned retarder film according to claim **1**, wherein the phase retardation of the substrate is less than 90°.

5. The patterned retarder film according to claim **4**, wherein the phase retardation of the substrate is substantially zero.

6. The patterned retarder film according to claim **1**, wherein the pattern configuration is a curable resin selected from the group consisting of acrylic resin, silicone and polyurethane.

7. The patterned retarder film according to claim **1**, wherein the highness of the relief structure of the first regions is in the range of 0.1 to 9.9 microns (μm).

8. The patterned retarder film according to claim **1**, wherein the highness of the relief structure of the first regions is in the range of 1 to 4 microns (μm).

9. The patterned retarder film according to claim **1**, wherein the width of the relief structure of the first regions is in the range of 10 to 900 microns (μm).

10. The patterned retarder film according to claim **1**, wherein the patterned retarder film is further adhered to at least one of functional optical films selected from a group consisting of polarizing film, hard-coating film, low reflective film, anti-reflective film and anti-glaring film.

11. A method for manufacturing a patterned retarder film, comprising the steps:

providing a substrate;

coating a curable resin on the first substrate;

embossing the curable resin with a predetermined pattern to form a pattern configuration comprising a plurality of first regions and a plurality of second regions, wherein the structure of the first regions and the second regions is grating-like stripe structure, the first regions and the second regions are parallel and interleaved with each other, and the structure of the first regions is relief structure;

curing the pattern configuration;

forming an alignment layer on the pattern configuration;

coating a liquid crystal layer on the alignment layer to cover the first regions and the second regions of the pattern configuration to a plane with a determined thickness;

aligning the liquid crystal layer with the alignment layer; and

curing the liquid crystal layer;

wherein the first phase retardation of the liquid crystal layer on the first regions and the second phase retardation of the liquid crystal layer on the second regions are different by 180°.

12. The method according to claim **11**, wherein the thickness of the substrate is in the range of 30 to 300 microns (μm).

13. The method according to claim **11**, wherein the substrate is selected from the group consisting of polyethylene terephthalate, polycarbonate, triacetate cellulose, polymethylmethacrylate, and cyclo-olefin polymer.

14. The method according to claim **11**, wherein the phase retardation of the substrate is less than 90°.

15. The method according to claim **11**, wherein the phase retardation of the substrate is substantially zero.

16. The method according to claim **11**, wherein the curable resin is selected from the group consisting of acrylic resin, silicone and polyurethane.

17. The method according to claim **11**, wherein the pattern configuration is cured by a process selected from the group consisting of UV radiation and heating treatment.

18. The method according to claim **11**, wherein in the step of forming an alignment layer on the pattern configuration, the alignment layer is formed by a process selected from the group consisting of micro-scratch alignment treatment, rubbing treatment, photo-alignment, SiO2 evaporation, and ion beam alignment.

19. The method according to claim **11**, wherein the step of aligning the liquid crystal layer with the alignment layer is conducted by heating treatment.

20. The method according to claim **11**, wherein the step of curing the liquid crystal layer is conducted by a curing process selected from the group consisting of UV radiation and heating treatment.

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